

## CLAIMS

1. A phototransistor, comprising:
  - a photo-sensitive semiconductor layer (8);
  - 5 a barrier layer (26, 40) extending across an active region (24) of the semiconductor layer under or over the semiconductor layer (8);
  - a drain region (20) laterally spaced from the active region (24) of the semiconductor layer (8);
  - a drain contact (22) connected to the drain region;
  - 10 a source layer (28,42) on the other side of the barrier layer (26) to the semiconductor layer (8);
  - a gate layer (4) on the opposite side of the semiconductor layer (8) to the barrier layer (26,40) and laterally overlapping the barrier layer (26,40) for controlling the barrier height of the barrier layer (26,40) to control conduction of
  - 15 electrons and holes between the source layer (28,42) and the active region (24); and
  - a gate insulator layer (6) between the gate layer (4) and the semiconductor layer (8);
  - wherein the structure allows light incident on the phototransistor to
  - 20 reach the active region (24) to create electron hole pairs in the active region, the holes accumulating at the barrier (26) to change the effective barrier height and hence the current flow between source layer (28) and drain region (20) through the active region (24).
- 25 2. A phototransistor according to claim 1 wherein the source layer (28) is of semiconductor doped to have the first conductivity type and the barrier layer (26) is a semiconductor layer doped to have a second conductivity type opposite to the first conductivity type.
- 30 3. A phototransistor according to claim 2 further comprising a transparent source electrode (30) connected to the source layer (28).

4. A phototransistor according to claim 1 wherein the barrier layer is an insulating barrier layer (40).

5. A phototransistor according to claim 4 wherein the source layer is  
5 a transparent source electrode (42).

6. A phototransistor according to any preceding claim wherein the semiconductor layer (8) is of doped amorphous silicon.

10 7. A phototransistor according to any preceding claim wherein the effective barrier height of the barrier (26,40) to electrons is be more than half the band gap.

8. A phototransistor array comprising an array (62) of  
15 phototransistors (60) according to any preceding claim arranged over a single substrate (2).

9. A phototransistor array according to claim 8 further comprising thin-film electronics (64) on the substrate (2).

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10. A method of operation of a phototransistor according to any of claims 1 to 7, the method comprising:

(a) applying a positive reset pulse to the gate (4) to allow holes accumulated at the barrier (26,40) to tunnel out into the source layer (28,42);

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(b) applying a frame gate voltage to the gate (4) during a frame period, the frame gate voltage allowing any electrons created by illumination in the active region to pass the barrier (26,40) but allow any holes created by illumination in the active region (24) to accumulate at the barrier (26,40), thereby reducing the effective height of the barrier (26,40) to electrons;

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(c) reading the source-drain current as a measure of the illumination.

11. A method according to claim 10 comprising repeating steps (a) to (c) to measure the illumination over a series of frame periods.